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**Allen et al.**

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- (54) **COUPLED FAIRING SYSTEMS**
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- (22) Filed: **Apr. 14, 2016**

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See application file for complete search history.

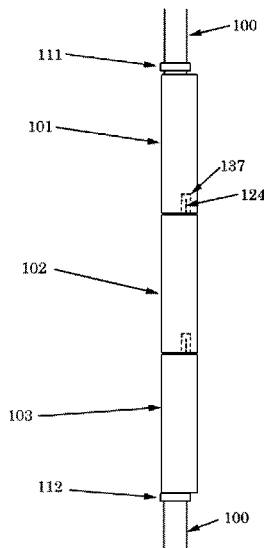
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(57) **ABSTRACT**

A vortex-induced vibration (VIV) suppression device including a body portion dimensioned to encircle an underlying tubular and a tail portion extending laterally outward from the body portion, the tail portion having a top end and a bottom end. The device further including an engaging member positioned at least at the top end or the bottom end of the body portion or the tail portion. The engaging member may be dimensioned to engage with an adjacent VIV suppression device.

**19 Claims, 11 Drawing Sheets**



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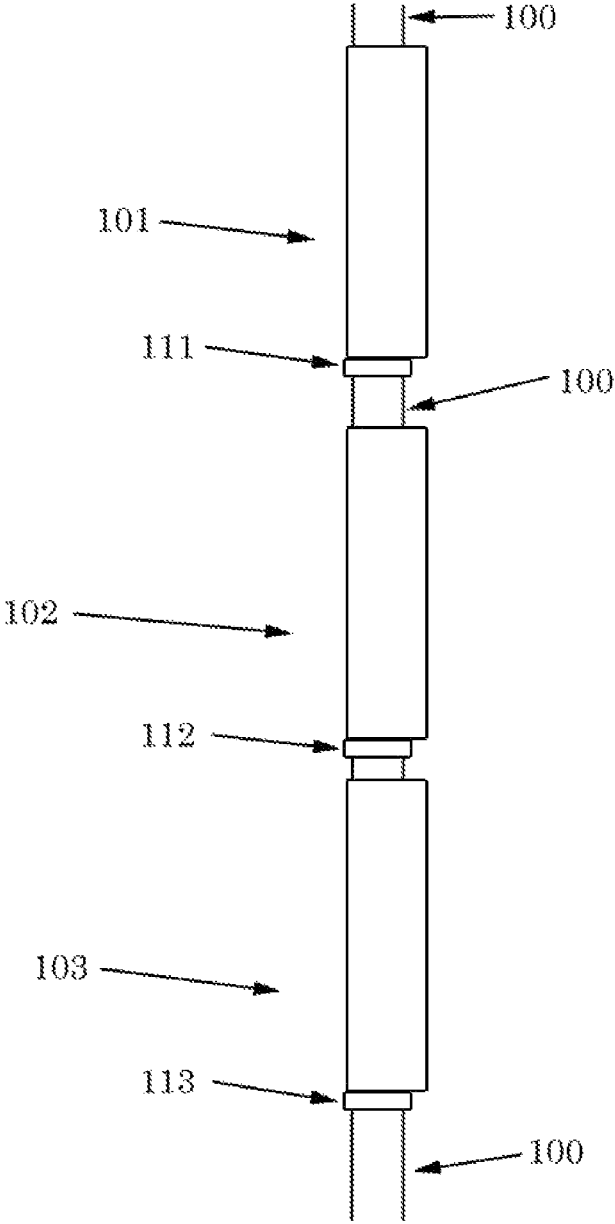


Fig. 1A

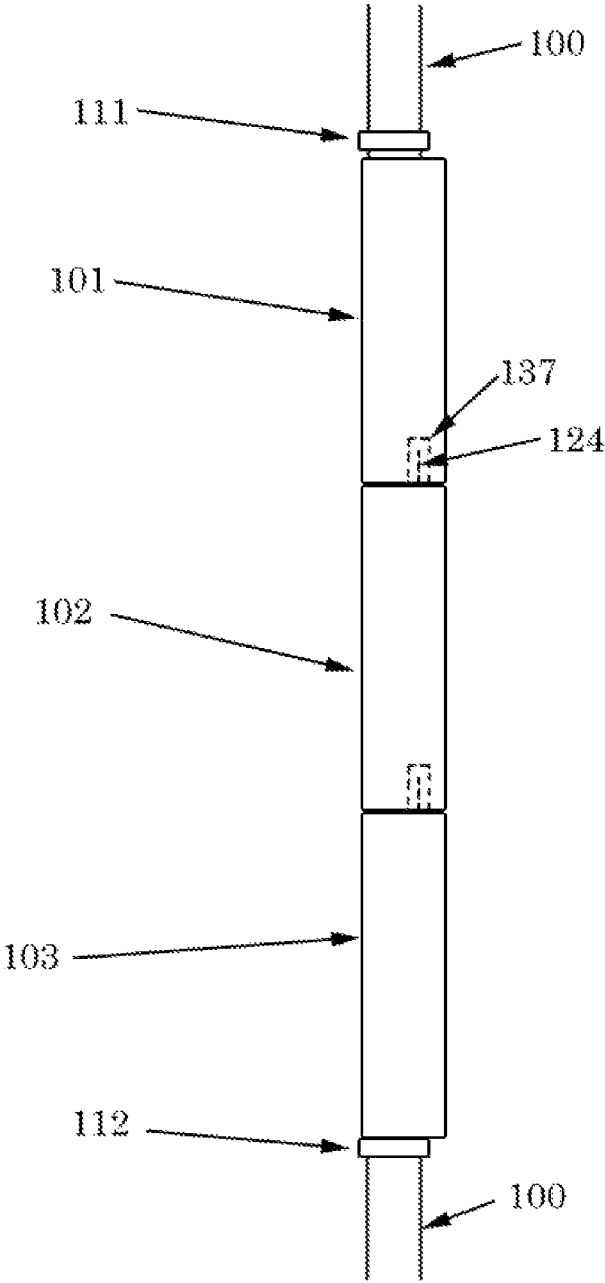


Fig. 1B

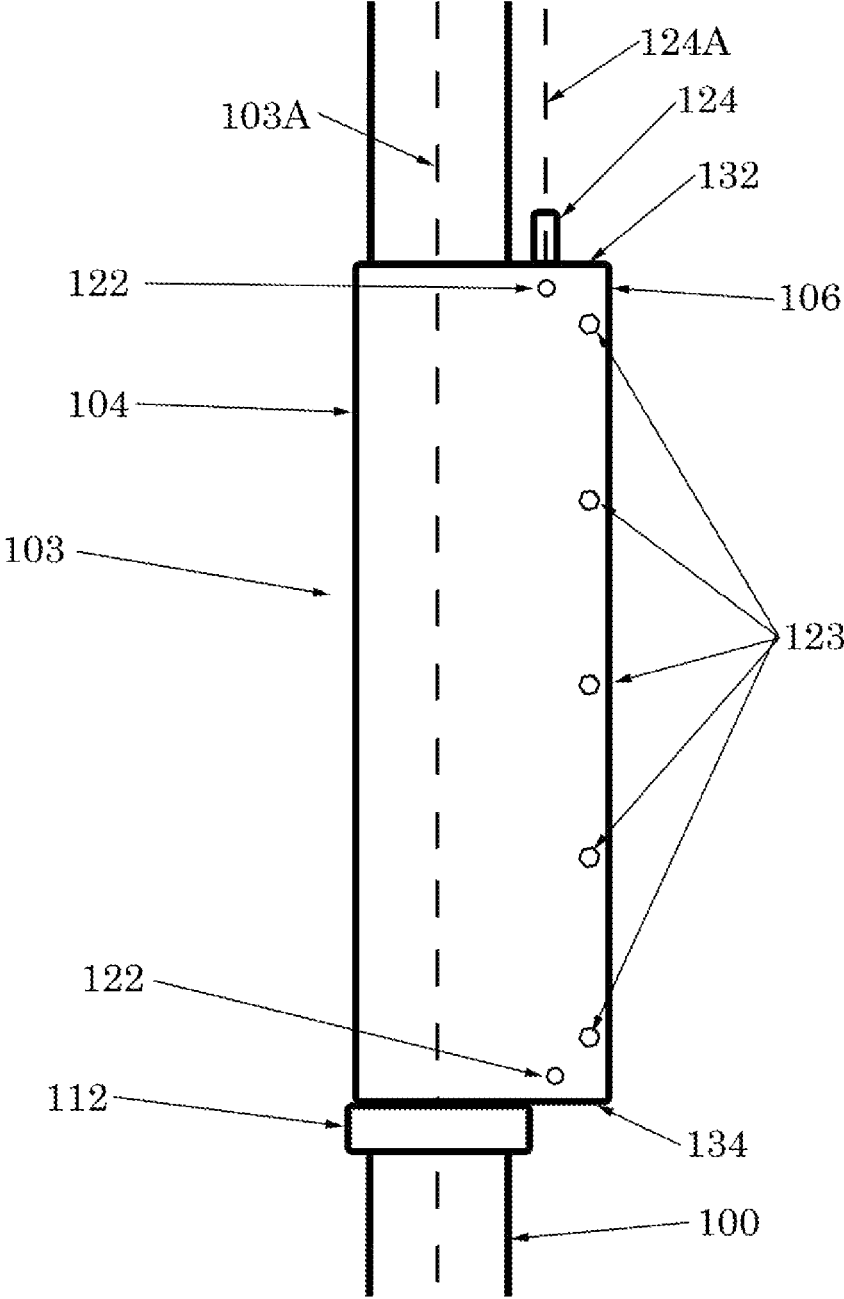


Fig. 2A

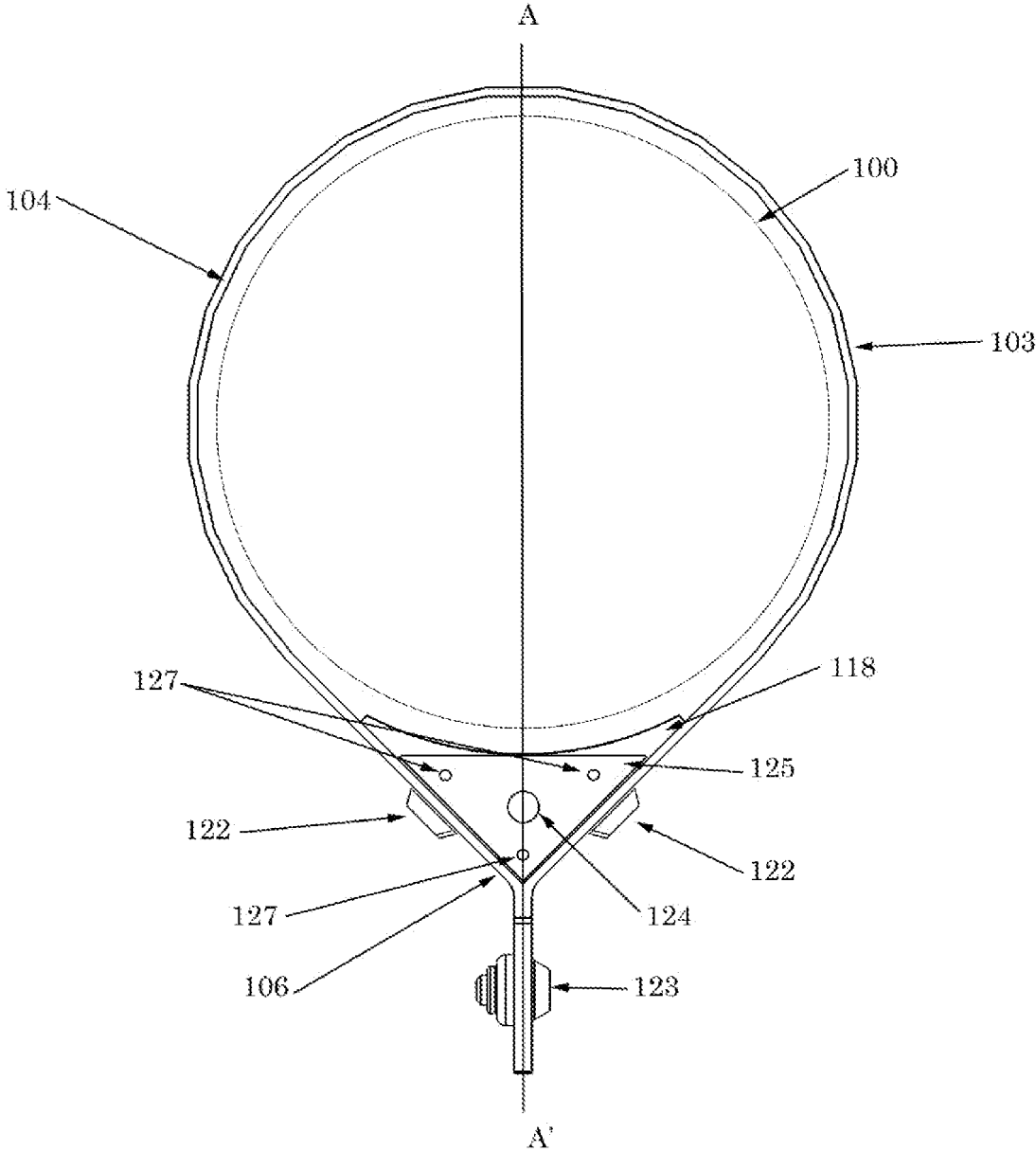


Fig. 2B

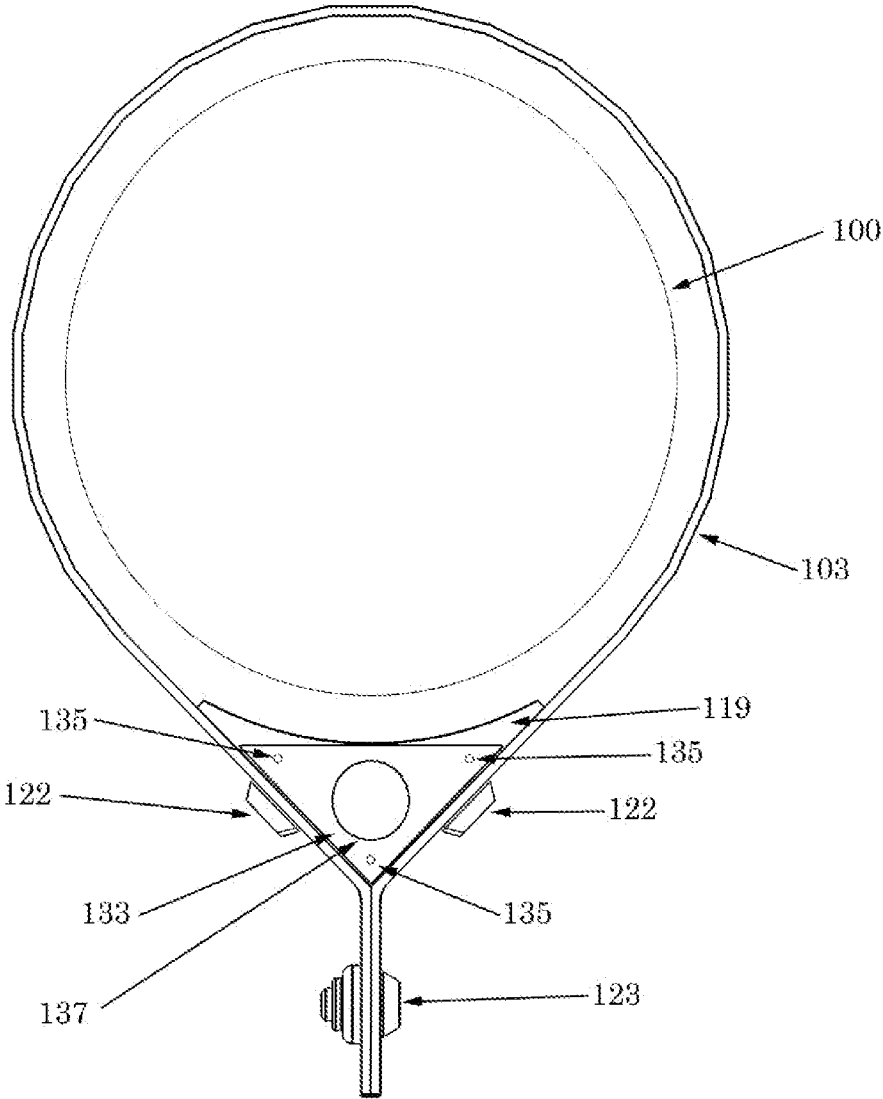


Fig. 2C

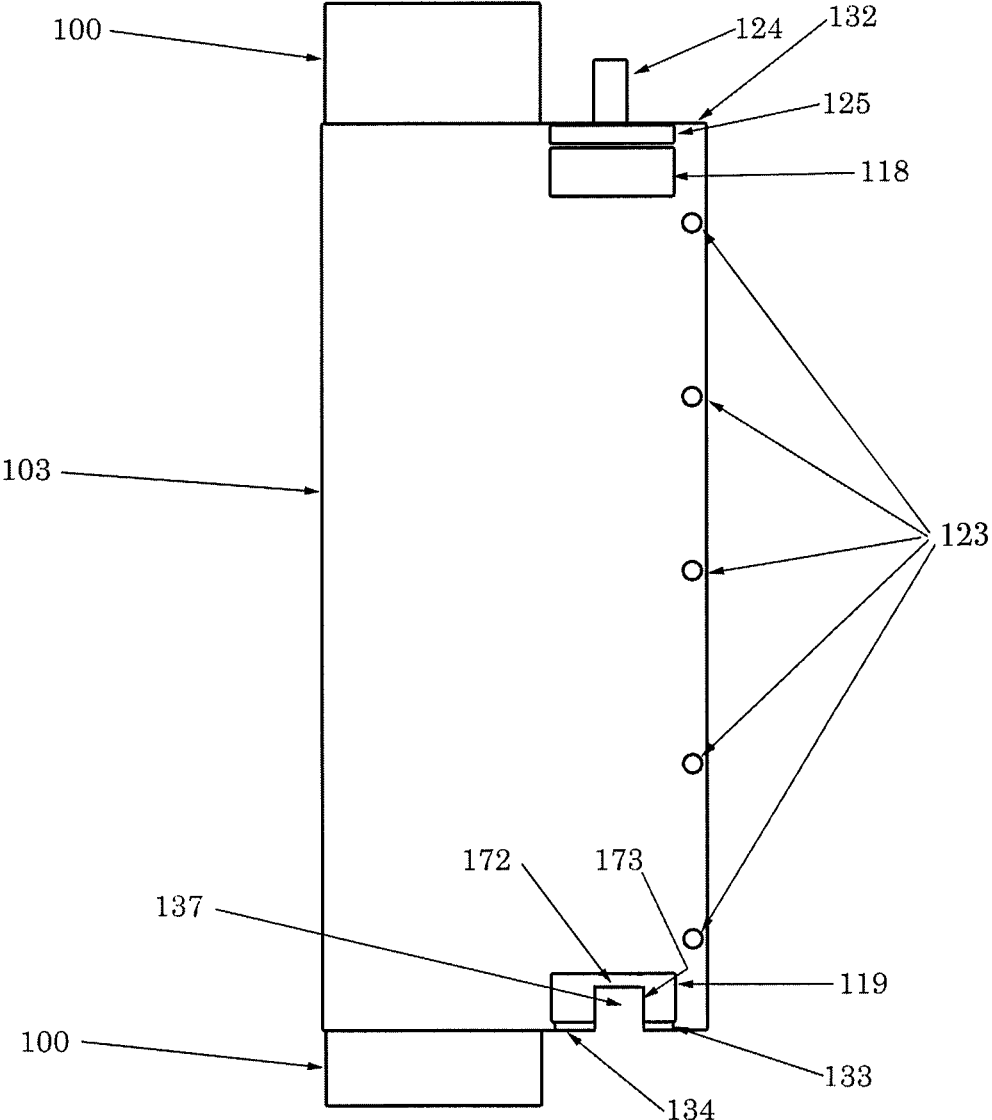


Fig. 2D

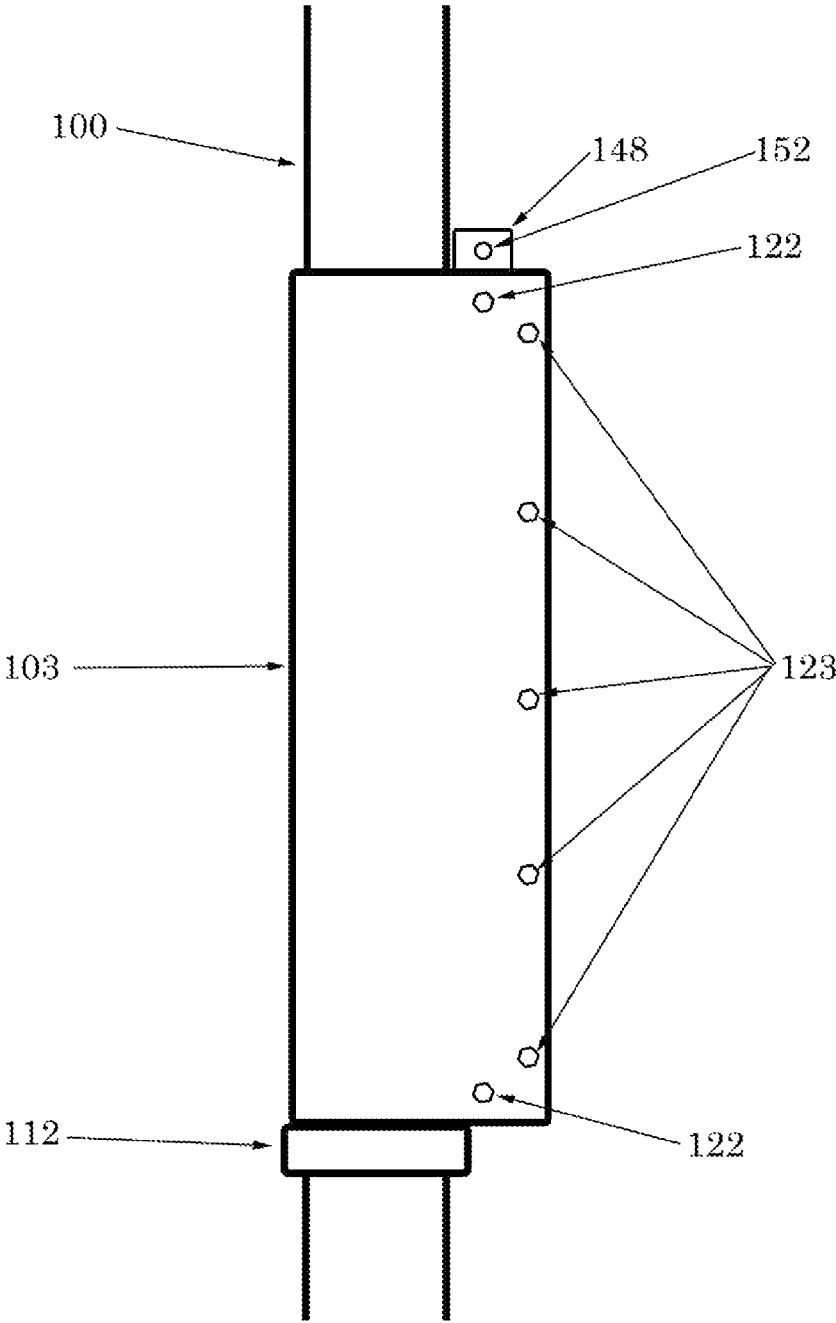


Fig. 3A

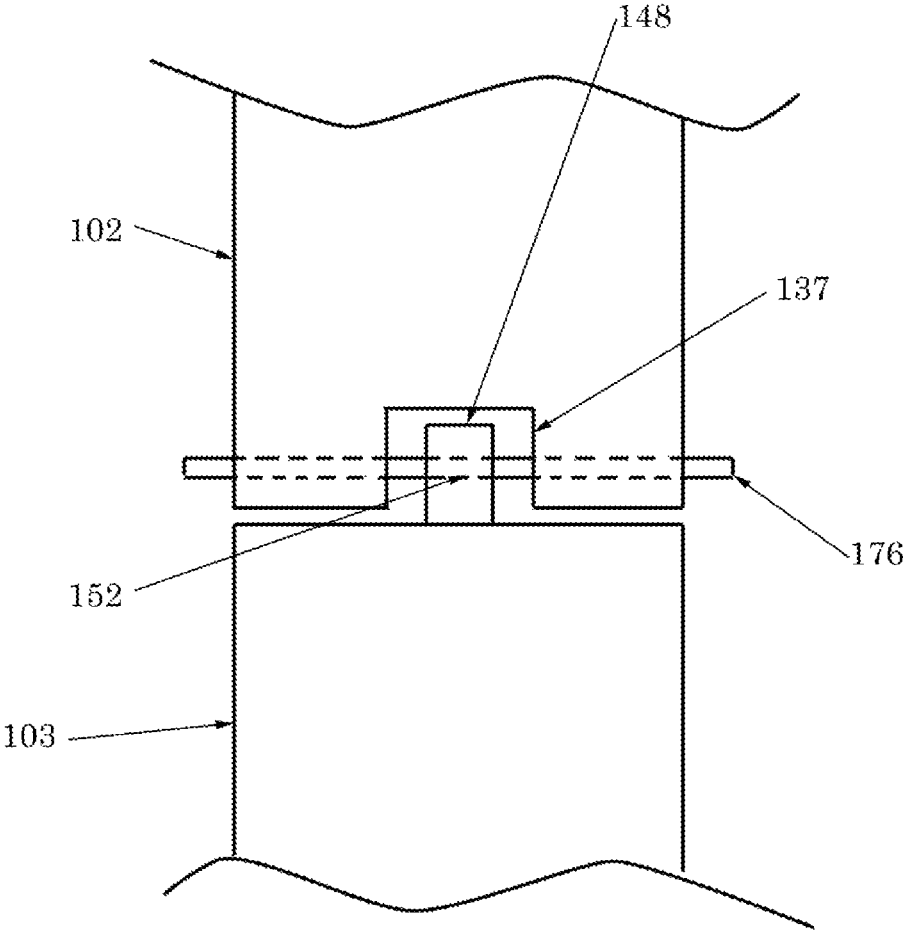


Fig. 3B

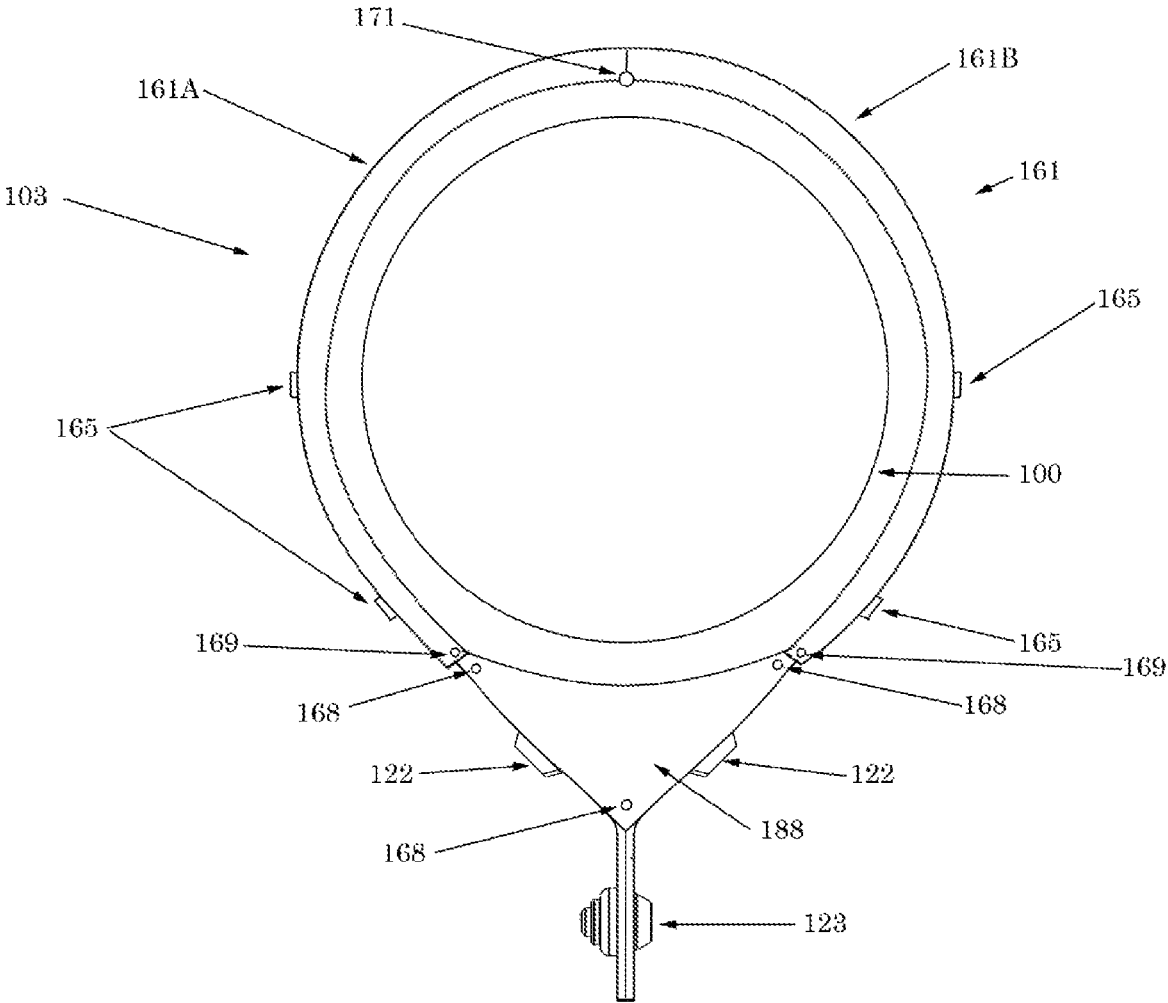


Fig. 4

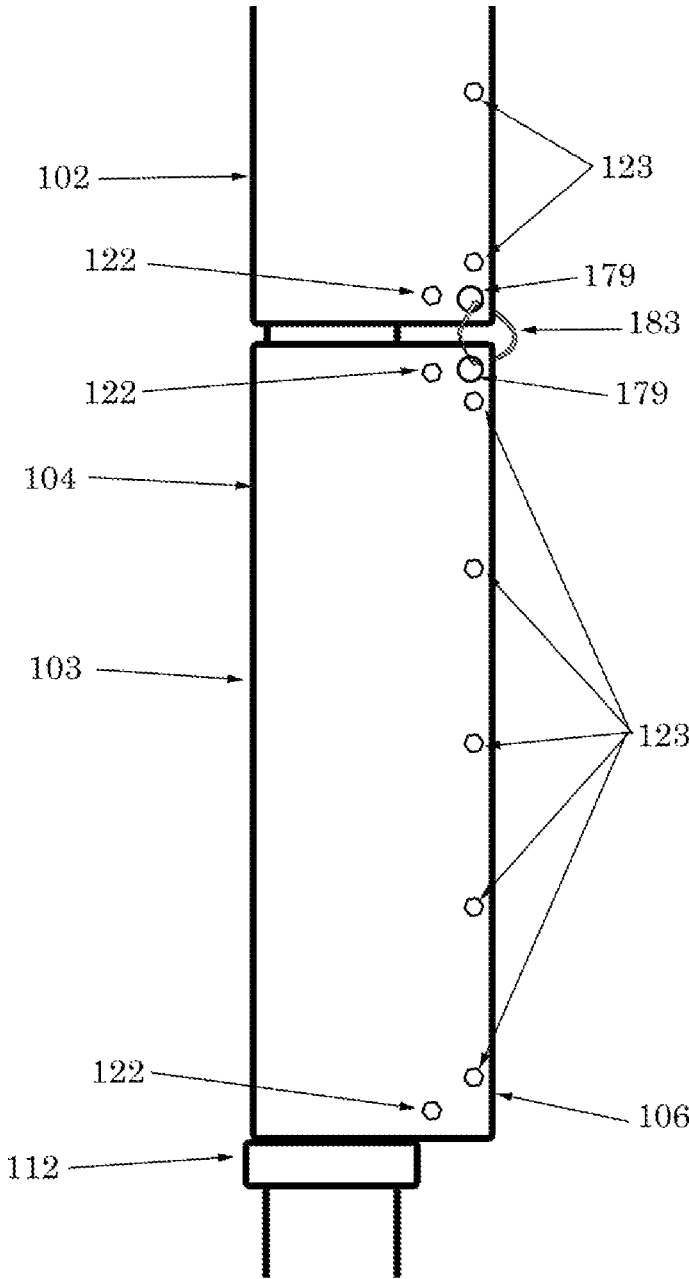


Fig. 5

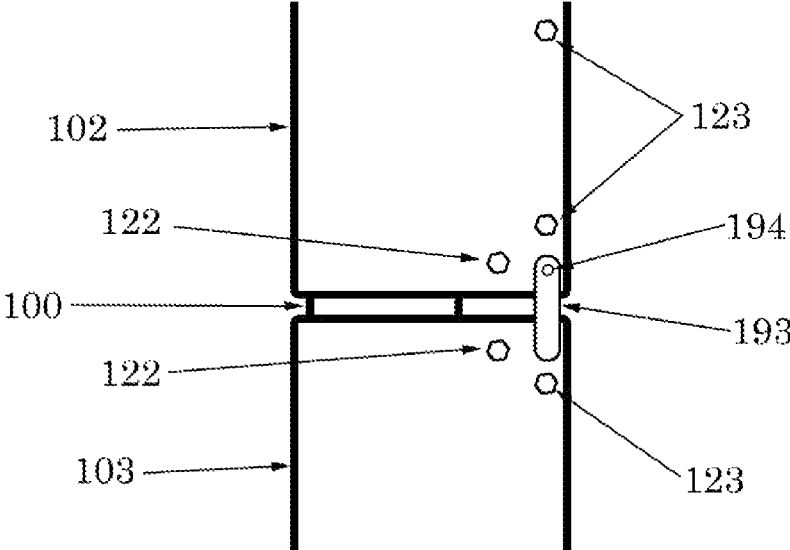


Fig. 6

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**COUPLED FAIRING SYSTEMS****CROSS-REFERENCE TO RELATED APPLICATION**

The application is a non-provisional application of U.S. Provisional Patent Application No. 62/149,421, filed Apr. 17, 2015 and incorporated herein by reference.

**FIELD**

Systems and devices for restraining or aligning adjacent fairings and suppressing marine growth between the fairings while still allowing for small movements of the fairings relative to each other. Other embodiments are also described herein.

**BACKGROUND**

A difficult obstacle associated with the exploration and production of oil and gas is management of significant ocean currents. These currents can produce vortex-induced vibration (VIV) and/or large deflections of tubulars associated with drilling and production. VIV can cause substantial fatigue damage to the tubular or cause suspension of drilling due to increased deflections. Both helical strakes and fairings can provide sufficient VIV suppression.

Fairings are a popular VIV suppression device. Fairings are usually separated by collars. The collars are clamped tight to the underlying pipe or tubular while the fairings are free to rotate. The collars restrain the fairings from sliding up or down or along the tubular axially.

In areas of potential marine growth, copper or other anti-fouling coatings or materials are used on one or more of the collar surfaces that face adjacent fairings to prevent marine growth from growing on this bearing surface and potentially causing the fairing to lock into position. If a fairing cannot weathervane due to being locked into position, its performance can suffer considerably even to the point where the vibration is increased and not suppressed. A locked fairing can also result in a substantial increase in drag forces on the tubular.

Presently, in areas of relatively high marine growth, a collar with copper is always used on surfaces that are adjacent to fairings. Thus, at least one collar is required for every fairing. While this works fairly well for many tubulars, for larger tubulars the density of collars relative to the tubular diameter is too high. This is because it is impractical to make fairings tall enough to maintain the same collar density for a larger tubular as for a smaller tubular. If multiple fairings are used for each collar by simply removing collars (e.g., removing every other collar in a series), there is the possibility that two adjacent fairings could be locked in an undesirable position relative to each other due to marine growth.

For areas where marine growth is less of a concern, there is the possibility of simply using more than one fairing for every collar without the worry of marine growth locking the fairings relative to each other. However, there may still be a desire to restrain adjacent fairings together in order prevent locking of adjacent fairings should unexpected marine growth levels be experienced.

One option is to mechanically lock adjacent fairings together. The problem with this approach is that the vortex shedding from the fairing is now relatively long (correlated). This can reduce the fairing efficiency for some flow situations. Ideally, the adjacent fairings move together but with

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some small freedom to move relative to each other, and without the possibility of marine growth locking them up at a large angle relative to each other.

**SUMMARY**

The present invention consists of methods for restraining or aligning adjacent fairings including methods that suppress marine growth between the fairings and methods that allow for small movements of the fairings relative to each other. In some embodiments, the invention is directed to a mechanism or device to restrain or align adjacent fairings. In some embodiments, the mechanism or device restrains or aligns adjacent fairings while still allowing some small motion of the fairings relative to each other. In some embodiments, the mechanism or device also inhibits marine growth between the adjacent fairings. In some embodiments, the mechanism or device increases fairing density along a tubular by utilizing fewer collars. The mechanism may be less expensive and/or faster to manufacture and/or install than the typical one-fairing-per-collar arrangement.

A vortex-induced vibration (VIV) suppression device including a body portion and a tail portion. The body portion may be dimensioned to encircle an underlying tubular. The tail portion may extend laterally outward from the body portion and have a top end and a bottom end. The body portion may have any size and shape suitable for holding the tail portion against an underlying tubular. For example, the body portion may be a sleeve like member that extends along substantially along the length of the body portion and an underlying tubular, and circumferentially around the underlying tubular. Alternatively, the body portion may be a strap or band that encircles the tubular and is attached at opposing ends to opposite sides of the tail portion. The device may further include an engaging member positioned at least at the top end or the bottom end of the tail portion. The engaging member may be dimensioned to engage with an adjacent VIV suppression device. In one embodiment, the engaging member may be an attachment member that extends from one of the top end or the bottom end of the tail portion. Still further, the engaging member may be a protrusion having a length dimension substantially parallel to a longitudinal axis of the body portion. In some embodiments, the engaging member may be a block attached to the top end or the bottom end and have a laterally extending opening formed entirely through the block. In other embodiments, the engaging member may be a recessed region formed inwardly from the bottom edge of the tail portion. Still further, the engaging member may be a receiving member formed within the tail portion, wherein the receiving member comprises a bottom surface and a sidewall extending from the bottom surface to the bottom end of the tail portion to form an opening in the bottom end. In addition, the engaging member may be a laterally extending channel formed through the tail portion. Still further, the engaging member may be a bar that extends from the top end or the bottom end of the tail portion to an adjacent VIV suppression device, and an end of the bar is positioned on, and attached to, the adjacent VIV suppression device. The VIV suppression device may also include a copper plate formed along one of the top end or the bottom end of the tail portion. The VIV suppression device may also include a support block positioned within the tail portion, and adjacent to the top end or the bottom end. In some embodiments, the engaging member is a first engaging member positioned at

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the top end of the tail portion and the device further includes a second engaging member positioned at the bottom end of the tail portion.

In other embodiments, the invention is directed to a system for suppressing a vortex-induced vibration (VIV) of a tubular. The system may include a VIV suppression device having a top end and a bottom end, a first engaging member positioned at the top end and a second engaging member positioned at the bottom end. The first engaging member may be different than the second engaging member, and the first engaging member and the second engaging member may be dimensioned to engage with an adjacent VIV suppression device. In some embodiments, the VIV suppression device may be a fairing including a cylindrical body portion dimensioned to encircle an underlying tubular and a tail portion extending laterally outward from the body portion. In one embodiment, the first engaging member is a protrusion extending from the top end and the second engaging member is a recessed region formed inwardly from the bottom end. In some cases, at least one of the first engaging member or the second engaging member is a laterally extending opening formed through the VIV suppression device, and the laterally extending opening is dimensioned to receive a cable for attaching the VIV suppression device to an adjacent VIV suppression device. The system may further include a support block positioned within the VIV suppression device near the top end, and the first engaging member may be a protrusion extending from the support block. The system may further include a plate positioned over the top end or the bottom end of the VIV suppression device and the plate may provide a bearing surface for an adjacent VIV suppression device. Still further, a marine growth suppression plate may be positioned on the top end or the bottom end of the VIV suppression device. In some embodiments, a copper ring is positioned on the top end or the bottom end of the VIV suppression device. The copper ring may include a first ring section and a second ring section, and the first ring section and the second ring section may be movably attached together by a hinge.

The above summary does not include an exhaustive list of all aspects of the present invention. It is contemplated that the invention includes all apparatuses that can be practiced from all suitable combinations of the various aspects summarized above, as well as those disclosed in the Detailed Description below and particularly pointed out in the claims filed with the application. Such combinations have particular advantages not specifically recited in the above summary.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments disclosed herein are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings in which like references indicate similar elements. It should be noted that references to "an" or "one" embodiment in this disclosure are not necessarily to the same embodiment, and they mean at least one.

FIG. 1A illustrates a side view of one embodiment of VIV suppression devices and collars on a tubular with a collar between each VIV suppression device.

FIG. 1B illustrates a side view of one embodiment of VIV suppression devices and collars on a tubular with more than one VIV suppression device between a pair of collars.

FIG. 2A illustrates a side view of one embodiment of a VIV suppression device with an attachment member for engaging an adjacent VIV suppression device.

FIG. 2B illustrates a top end view of the VIV suppression device of FIG. 2A.

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FIG. 2C illustrates a bottom end view of the VIV suppression device of FIG. 2A.

FIG. 2D illustrates a cross section of the VIV suppression device of FIG. 2B along line A-A'.

FIG. 3A illustrates a side view of one embodiment of a VIV suppression device utilizing a block for locking two adjacent VIV suppression devices together.

FIG. 3B illustrates a magnified front end view of the VIV suppression device of FIG. 3A utilizing a block for locking two adjacent VIV suppression devices together.

FIG. 4 illustrates a top end view of one embodiment of a VIV suppression device with copper on the VIV suppression device acting as a bearing surface.

FIG. 5 illustrates a side view of one embodiment in which two VIV suppression devices are connected.

FIG. 6 illustrates a side view of another embodiment in which two adjacent VIV suppression devices are connected.

#### DETAILED DESCRIPTION

In this section we shall explain several preferred embodiments with reference to the appended drawings. Whenever the shapes, relative positions and other aspects of the parts described in the embodiments are not clearly defined, the scope of the embodiments is not limited only to the parts shown, which are meant merely for the purpose of illustration. Also, while numerous details are set forth, it is understood that some embodiments may be practiced without these details. In other instances, well-known structures and techniques have not been shown in detail so as not to obscure the understanding of this description.

Referring now to the invention in more detail, FIG. 1A presents VIV suppression devices **101**, **102**, and **103** and collars **111**, **112**, and **113** surrounding tubular **100**. VIV suppression devices **101**, **102**, and **103** may, in one embodiment, be fairings having, for example, a cylindrical body portion and a substantially triangular shaped tail, which is dimensioned to suppress VIV about tubular **100** by streamlining the current flow past the tubular. The fairings may have, for example, a clam-shell configuration such that they can be opened and closed around the tubulars. It is to be understood, however, that although a fairing is illustrated, the VIV suppression devices **101**, **102**, and **103** may be any other type of device suitable for suppressing VIV about tubular **100**, for example, a helical strake, a herring device, a cylindrical or other shaped sleeve, or the like, or a combination of these devices.

Collars **111**, **112**, and **113** may be positioned between VIV suppression devices **101**, **102** and **103** to help position the devices at the desired axial location. Collars **111**, **112**, and **113** may have a height which is less than that of the associated VIV suppression device, for example, a height which is less than 50 percent of the height of the VIV suppression device, or less than 25 percent a height of the VIV suppression device or less than  $\frac{1}{8}$  a height of the VIV suppression device. Representatively, collars **111**, **112**, and **113** may have a height of from about 1 inch to about 6 inches, for example, from about 2 inches to about 5 inches, or from 3 inches to 4 inches. In other words, collars **111**, **112**, and **113** are not intended to cover more of the tubular **100** than VIV suppression devices **101**, **102**, **103**, rather they cover only a small portion of the tubular length which is exposed between VIV suppression devices positioned along tubular **100**.

Collars **111**, **112**, and **113** may include annular or ring shaped body portions formed by one continuous structure or, in some embodiments, formed by segments, which when

connected form a ring around tubular **100**. Collars **111**, **112**, and **113** may further include attachment members that are used to attach the collars around tubular **100**. For example, collars **111**, **112**, and **113** may include bolts, clamps, hinges or other fasteners can be used to attach adjacent ring segments together.

Collars **111**, **112**, and **113** are clamped tightly to tubular **100** while VIV suppression devices **101**, **102**, and **103** (e.g., fairings) are free to rotate around tubular **100**. VIV suppression devices **101**, **102**, and **103** may be made of any suitable shape or material. Collars **111**, **112**, and **113** may be made of any suitable shape or material. Tubular **100** may be made of any suitable shape or material.

Referring now to FIG. 1B, VIV suppression devices **101**, **102**, and **103** are shown adjacent to each other and surrounded by collars **111** and **112**. Tubular **100** is under VIV suppression devices **101**, **102**, and **103** and collars **111** and **112**.

Again referring to FIG. 1B, VIV suppression devices **101**, **102**, and **103** are free to rotate around tubular **100** while collars **111** and **112** are clamped to tubular **100**. One or more VIV suppression devices **101**, **102**, and **103** may also be attached to each other at their ends. VIV suppression devices **101**, **102**, and **103** may be connected by any suitable means including, but not limited to, clamps, blocks, fasteners, pins, chemical bonding, rope, cable, or cable ties. In one embodiment, VIV suppression devices **101**, **102**, and **103** may be attached by an attachment member **124** extending from one end of one device, that is received within a receiving member **137** of another adjacent device, as will be discussed in more detail in reference to FIG. 2A-2D.

Referring now to FIG. 2A, FIG. 2A illustrates one embodiment of a VIV suppression device having an engaging member for attaching the VIV suppression device to another VIV suppression device. VIV suppression device **103** is shown sitting on collar **112** over underlying tubular **100**. VIV suppression device **103** may be a fairing having a body portion **104** dimensioned to encircle tubular **100** and a tail portion **106** extending laterally outward from the body portion **104** (away from tubular **100**). Tail fasteners **123** connect opposing sides of tail portion **106** of VIV suppression device **103** to itself after it is placed around tubular **100**. Block fasteners **122** connect underlying support blocks (see FIG. 2B) to device **103**. VIV suppression device **103** may include an engaging member, for example in this embodiment, the engaging member is an attachment member **124** extending from its top edge, parallel to its longitudinal axis, for attaching device **103** to an adjacent VIV suppression device (e.g., device **101** or **102**). Attachment member **124** may be a male piece which is attached to a support block within device **103**, or a wall of device **103** itself. In other embodiments, the engaging member may be a female piece formed at an end of VIV suppression device **103**, as will be described in more detail in reference to FIG. 2D.

Again referring to FIG. 2A, attachment member **124** is used to mate with another engaging member, for example, a receiving member (e.g., a female piece) of an adjacent VIV suppression device (not shown). Attachment member **124** may be of any suitable shape or size and may connect to any part of VIV suppression device **103**. Representatively, in one embodiment, VIV suppression device **103** includes a top end **132** and a bottom end **134**, and attachment member **124** is connected at a top end **132** or bottom end **134** of device **103**. Attachment member **124** may be made of any suitable material including, but not limited to, plastic, metal (including copper), fiberglass, wood, rubber, or elastomer. Attachment member **124** may include more than one component.

For example, all or part of attachment member **124** may consist of a rubber, elastomer, or other spring material/device which would allow the adjacent VIV suppression devices to move relative to VIV suppression device **103**. Multiple attachment members **124** may also be present. Attachment member **124** can be oriented in the upward position on the top end **132** of the VIV suppression device **103** or in the downward position on the bottom end **134** of the VIV suppression device **103**. Representatively, in one embodiment attachment member **124** is a protruding member having a length dimension **124A** that is substantially parallel to a longitudinal axis **103A** of VIV suppression device **103**. It should be understood, however, that although attachment member **124** is shown in this embodiment extending from the top edge of the tail portion **106** of device **103**, it may extend from a rib or other member outside of device **103**, so long as it is still operable to engage device **103** with a receiving member of an adjacent device.

Referring now to FIG. 2B, this figure shows an end view of one embodiment of the VIV suppression device of FIG. 2A. From this view, it can be seen that VIV suppression device **103** includes a cylindrical body portion **104** surrounding tubular **100**, which terminates at a substantially triangular shaped tail portion **106**. Both the cylindrical body portion **104** and the tail portion **106** may be formed by one integrally formed wall of VIV suppression device **103**. Alternatively, body portion **104** may be a clamshell type configuration with sides that are hinged together at one end, and fastened at the other end, once body portion **104** is positioned around tubular **100**. Support block **118** may be attached to VIV suppression device **103** using block fasteners **122** or other means. Tail fasteners **123** connect the sides of VIV suppression device **103** to itself after it is closed around tubular **100**. In one embodiment, a copper plate **125** is attached to support block **118** by plate fasteners **127**. Attachment member **124** may extend from copper plate **125** (in a direction perpendicular to a surface of copper plate **125**).

Again referring to FIG. 2B, support block **118** may be used to give strength to VIV suppression device **103**. Copper plate **125** may act as a bearing surface for an adjacent VIV suppression device and suppresses marine growth on the bearing surface. Attachment member **124** extends above copper plate **125** to mate with a corresponding female piece of an adjacent VIV suppression device. Attachment member **124** may be attached to copper plate **125** by any suitable means including fastening or welding, or it may be integral to copper plate **125**. Attachment member **124** may pass through all or part of support block **118**. Attachment member **124** may be of any suitable size or shape and more than one attachment member **124** may be used (each male piece may be identical or may be different from each other). Copper plate **125** may be of any suitable size or shape and any number of plate fasteners **127** may be used to attach it to support block **118**. Copper plate **125** may be used as both a support block and other structure in addition to its anti-fouling function.

Referring now to FIG. 2C, FIG. 2C shows an end view of an embodiment of the VIV suppression device of FIG. 2A. The end view may be the opposite end of VIV suppression device **103** that is shown in FIG. 2B, or an alternative configuration for the VIV suppression device end shown in FIG. 2B. VIV suppression device **103** is shown surrounding tubular **100**. Support block **119** is attached to VIV suppression device **103** using block fasteners **122**. In cases where VIV suppression device **103** is a fairing, tail fasteners **123** connect the sides of the fairing to itself after it is closed

around tubular **100**. A copper plate **133** may be connected to support block **119** by plate fasteners **135**. In this embodiment, a receiving member **137** for receiving an attachment member (e.g., a male fastener) from an adjacent VIV suppression device is formed in copper plate **133** and optionally all or part of support block **119**. The receiving member **137** may be an opening dimensioned to receive an attachment member such as that disclosed in reference to FIGS. **2A** and **2B**. It should be recognized that in some embodiments, one end of VIV suppression device **103** may include receiving member **137** and the other end includes attachment member **124**. In other cases, one end of VIV suppression device **103** includes an attachment member **124** or receiving member **137**.

Again referring to FIG. **2C**, copper plate **133** acts as a bearing surface for an adjacent VIV suppression device and impedes marine growth on the bearing surface. Receiving member **137** is used to receive a male piece (e.g., attachment member **124**) from an adjacent VIV suppression device. Receiving member **137** may be of a diameter approximately equal to the diameter of the corresponding male piece, or may be of a larger diameter than the corresponding male piece. By having a larger diameter than the corresponding male piece, the adjacent VIV suppression devices (e.g., fairings) are able to move some relative to each other. Receiving member **137** may be non-circular in cross section. Receiving member **137** may be sufficiently deep to allow full penetration of the corresponding male piece or may allow only partial penetration of the male piece. More than one receiving member **137** may be present and each opening may be identical or different from the other openings. Copper plate **133** may be of any suitable size or shape and any number of plate fasteners **135** may be used to attach it to support block **119**. It is also recognized that materials other than copper may be used for the bearing plates (e.g., copper plate **125** and/or copper plate **133**) whether or not that material has the ability to suppress marine growth, and it is recognized that the bearing plates do not even need to be present and instead the support blocks or other structures may be used to house the male piece and opening.

Referring now to FIG. **2D**, FIG. **2D** illustrates a cross sectional view of FIG. **2B**, along line A-A'. From FIG. **2D** it can be seen that VIV suppression device **103** is positioned around tubular **100** with support blocks **118** and **119**, attachment member **124** at one end, copper plates **125** and **133**, and receiving member **137** at another end. From this view, it can be seen that in one embodiment, receiving member **137** is a recessed region, pocket, channel or the like, formed inwardly from the bottom edge **134** of VIV suppression device **103**. In this aspect, receiving member **137** may be defined by a bottom surface **172** and sidewalls **173** that extend from the bottom surface **172** and form an opening within which an attachment member **124** can be inserted, at the bottom edge of device **103**. In addition, it can be seen that copper plates **125** and **133** are plates formed along the top and bottom edges of VIV suppression device **103**.

Again referring now to FIG. **2D**, from this view it can be seen that attachment member **124** extends upwards (e.g., parallel to a longitudinal axis of device **103**) from the VIV suppression device **103**, support block **118** and copper plate **125**. Attachment member **124** may consist of a bolt, pin, stud, pipe, or other appurtenance. It may be attached to copper plate **125**, support block **118**, or both copper plate **125** and support block **118**. Attachment member **124** may be integral to copper plate **125** and/or support block **118**. It may

be kept in place by interference, for example a bolt whose head is sandwiched between copper plate **125** and support block **118**.

Still referring to FIG. **2D**, while this figure shows a VIV suppression device (e.g., a fairing) with one attachment member **124** at one end and one receiving member **137** at another end, it is possible for the VIV suppression device to have all male pieces, all female pieces or any combination thereof. It is also possible for one end to have both male and female pieces for mating with an adjacent VIV suppression device. It is also possible for a VIV suppression device to have a single mating piece, for example a mating piece at one end and not the other.

Referring now to FIG. **3A**, FIG. **3A** shows a side view of a VIV suppression device and a collar, for example VIV suppression device **103** and collar **112** described in reference to FIG. **1B**, on tubular **100**. Fasteners **123** attach VIV suppression device **103** to itself after it is placed around tubular **100**. Block fasteners **122** attach VIV suppression device **103** to internal blocks.

VIV suppression device **103** may further include a mating block **148** extending from a top end of device **103**. Mating block **148** may be attached at one end to the end of device **103** by a top block fastener **122** and have an opening **152** at its other end. Mating block **148** may be used to attach VIV suppression device **103** to an adjacent VIV suppression device (such as a fairing) as shown in FIG. **3B**. In particular, an adjacent VIV suppression device **102** having a receiving member **137** may be aligned with the mating block **148** as shown in FIG. **3B**. A block fastener **176** may then be inserted through the adjacent VIV suppression device **102** and opening **152** within mating block **148** to fasten VIV suppression device **102** to VIV suppression device **103**. In this aspect, opening **152** may be a laterally extending opening formed entirely through mating block **148** (e.g., from one side to the other).

Again referring to FIG. **3A** and FIG. **3B**, mating block **148** may be of any suitable size or shape and may have any number of attachment points. Any number of mating blocks **148** may be used and each block may be identical or different. While a block fastener **176** is described as being used to attach mating block **148** to VIV suppression device **102** and to attach mating block **148** to VIV suppression device **103**, other attachment methods may also be used and mixed or matched including, but not limited to, pinning, welding, clamping, chemical bonding, or an interference fit. In addition, an external plate or block may be substituted for mating block **148** and any number may be used and they may be located at any place on VIV suppression device **103** that allows them to be used to attach an adjacent VIV suppression device (e.g., a fairing). Mating block **148** may be of any suitable material.

Referring now to FIG. **4**, VIV suppression device **103**, for example a fairing, is shown surrounding tubular **100** and attached to itself by tail fastener **123**. Block fasteners **122** attach VIV suppression device **103** to an internal block (generally recessed below copper plate **188**). Copper plate **188** is attached to the internal block by plate fasteners **168**. Copper ring **161** is attached to VIV suppression device **103** by ring fasteners **165** and copper ring **161** is split into two parts **161A** and **161B** at hinge **171**. Copper ring **161** is also optionally attached to copper plate **188** by end fasteners **169**.

Again referring to FIG. **4**, copper ring **161** and copper plate **188** provide a bearing surface for VIV suppression device **103** that completely covers the end of VIV suppression device **103** so that none of VIV suppression device **103** is directly exposed to an adjacent collar or VIV suppression

device. Copper ring **161** is shown extending over one or more sides of VIV suppression device **103**, which utilizes ring fasteners **165** which go through the side of both copper ring **161** and VIV suppression device **103**. In general, it will be desirable to have both copper ring **161** and copper plate **188** to be coplanar so that there is not a lip to catch on an adjacent VIV suppression device or collar.

Still referring to FIG. 4, copper ring **161** and copper plate **188** may be attached by any suitable method and may or may not be attached to each other. It is also possible for copper ring **161** and copper plate **188** to be a single piece or it is possible for them to be connected to each other and only one of them connected to VIV suppression device **103**. Copper ring **161** and copper plate **188** may be of any suitable size or shape and they may also be made of other materials or made of more than one material. Ring fasteners **165** can be installed radially into the side of the VIV suppression device body or, if the VIV suppression device wall is sufficiently thick, they can be installed axially into the VIV suppression device wall.

Referring now to FIG. 5, two VIV suppression devices, for example VIV suppression devices **102** and **103**, are attached around the underlying tubular using tail fasteners **123** while collar **112** is clamped to the underlying tubular. Block fasteners **122** are used to attach internal support blocks to VIV suppression devices **102** and **103**. Fastener channels or openings **179** are present in VIV suppression devices **102** and **103** and fastener **183** is used to connect VIV suppression devices **102** and **103** through fastener openings **179**. The fastener channels or openings **179** may extend laterally through the tail portions **106** of VIV suppression devices **102** and **103**. In other words, channels or openings **179** extend entirely through the tail portions **106**, from side to the other, in a lateral, as opposed to axial, direction.

Again referring to FIG. 5, fastener **183** illustrates another method for connecting two adjacent VIV suppression devices together while providing the devices with a small range of motion. Fastener **183** may be a cable of any suitable size or shape and other structures may be used in its place including rope, clips, pins, and cable ties. Fastener **183** may be made of any suitable material including, but not limited to, plastic, metal, synthetic, and fiberglass. Fastener openings **179** may be of any size and shape and may be identical or different. Multiple fastener openings **179** and fasteners **183** may be used for a single connection. Fastener openings **179** and fasteners **183** may be located anywhere on the VIV suppression device body, for example they may be located near the nose of the VIV suppression device instead of the VIV suppression device tail shown in FIG. 4.

Referring now to FIG. 6, FIG. 6 illustrates a magnified side view of one embodiment of an interface between two VIV suppression devices. VIV suppression devices **102** and **103** are attached around the underlying tubular **100** using tail fasteners **123**. Block fasteners **122** are used to attach internal support blocks to VIV suppression devices **102** and **103**. Clip **193** is attached to VIV suppression device **102** by clip fastener **194**.

Again referring to FIG. 6, clip **193** may include one or more elongated bar or pole like members that extend in an axial direction from VIV suppression device **103** outwards towards an adjacent VIV suppression device **102** and restricts the relative motion between the two devices. More than one clip **193** may be used, for example one clip may extend down the outside of an adjacent VIV suppression device on one side while another clip may extend down the outside of an adjacent VIV suppression device on the opposite side, thereby restricting its relative rotation in both

directions. Clip **193** may be of any suitable size or shape. Clip **193** may be made of any suitable material including, but not limited to, metal (including copper), plastic, and rubber or elastomer. Clip **193** may be integral to VIV suppression device **102**, VIV suppression device **103**, or clip fastener **194**. Clip **193** may consist of more than one member, and VIV suppressions device **103** may have a receiving member that interfaces with clip **193**. Each component discussed herein may be mixed and match and may be identical or different.

The above aspects of this invention may be mixed and matched in any manner suitable to achieve the purposes of this invention. It is recognized that, while fairings have been used to illustrate the invention herein, the concepts presented may be applied to any VIV suppression device that allow for motion of the suppression devices. This includes splitter plates and other rotatable devices. It is also recognized that the ideas herein can be applied to other styles of fairings, but example one or more splitter plates, fairings without end blocks, and fairings where copper plates or other anti-fouling structures discussed herein are used for structural support. In broad embodiments, the present invention consists of methods for aligning and/or restraining or locking two adjacent fairings.

While the foregoing written description of the invention enables one of ordinary skill to make and use what is considered presently to be the best mode thereof, those of ordinary skill will understand and appreciate the existence of variations, combinations, and equivalents of the specific embodiment, method, and examples herein. For several of the ideas presented herein, one or more of the parts may be optional. The invention should therefore not be limited by the above described embodiment, method, and examples, but by all embodiments and methods within the scope and spirit of the invention.

What is claimed is:

1. A vortex-induced vibration (VIV) suppression system comprising:
  - a first vortex-induced vibration device comprising:
    - a body portion dimensioned to partially encircle an underlying tubular;
    - a tail portion extending laterally outward from the body portion, the tail portion having a first side wall and a second side wall that are formed as a single piece with the body portion and extend from the body portion toward one another to form an enclosed space around an underlying tubular partially encircled by the body portion, and each of the first side wall and the second side wall having a top end and a bottom end;
    - a block positioned within the enclosed space and attached to interfacing surfaces of the first side wall and the second side wall to secure the body portion and the tail portion to the underlying tubular; and
    - a bar aligned with the enclosed space and extending from the block; and
    - a second vortex-induced vibration device that is adjacent to the first vortex-induced vibration device, and the adjacent VIV suppression device comprises an opening for receiving the bar, and the opening has a cross-sectional dimension that is greater than that of the bar.
  2. The VIV suppression device of claim 1 wherein the body portion and the tail portion are formed of a same material.

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3. The VIV suppression device of claim 1 wherein the bar comprises a length dimension substantially parallel to a longitudinal axis of the body portion.

4. The VIV suppression device of claim 1 wherein the body portion and the first side wall and the second side wall of the tail portion are a single piece.

5. The VIV suppression device of claim 1 wherein the bar extends from the block above the top end of the first side wall or the second side wall, the device further comprising a recessed region formed inwardly from the opening in the bottom end of the first side wall or the second side wall.

6. The VIV suppression device of claim 5 wherein the recessed region comprises a bottom surface and a sidewall extending from the bottom surface to the bottom end of the first side wall and the second side wall to form an opening at the bottom end.

7. The VIV suppression device of claim 1 wherein the bar comprises a fastener that extends through a channel formed through the first side wall or the second side wall of the tail portion.

8. The VIV suppression device of claim 1 further comprising:

a copper plate formed along one of the top end or the bottom end of the first side wall or the second side wall of the tail portion.

9. The VIV suppression device of claim 1 wherein the bar is a bolt.

10. The VIV suppression device of claim 1 further comprising:

a copper plate attached to the support block.

11. A system for suppressing a vortex-induced vibration (VIV) of a tubular, the system comprising:

a VIV suppression device having a first side wall and a second side wall that taper toward one another and partially encircle an underlying tubular, and a fin extending from the first side wall or the second side wall;

a bolt extending from, and fixedly attached to, a top end of the VIV suppression device; and

an opening formed through a portion of the first side wall or the second side wall at a bottom end of the VIV suppression device.

12. The system of claim 11 wherein the VIV suppression device is a tail fairing further comprising a cylindrical body portion dimensioned to encircle a remaining portion of the underlying tubular and the first side wall and the second side wall are attached to the body portion and extend laterally outward from the body portion.

13. The system of claim 11 wherein the opening is part of a recessed region having sides formed inwardly from the bottom end of the VIV suppression device to a closed bottom surface within the VIV suppression device, and,

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wherein the bolt is a first bolt dimensioned to engage with a first adjacent VIV suppression device, and the opening is dimensioned to engage with a second bolt coupled to a second adjacent VIV suppression device, and the opening is substantially larger than the second bolt of the second adjacent VIV suppression device such that the second bolt of the adjacent VIV suppression device is operable to be inserted within the opening without touching of the sides of the recessed region.

14. The system of claim 11 further comprising: a support block positioned within the VIV suppression device near the top end, and wherein the bolt is fixedly mounted to the support block.

15. The system of claim 11 further comprising: a plate positioned over the top end or the bottom end of the VIV suppression device, wherein the plate provides a bearing surface for an adjacent VIV suppression device.

16. The system of claim 11 further comprising: a marine growth suppression plate positioned on the top end or the bottom end of the VIV suppression device.

17. The system of claim 11 further comprising: a copper ring positioned on the top end or the bottom end of the VIV suppression device.

18. The system of claim 17 wherein the copper ring comprises a first ring section and a second ring section, and wherein the first ring section and the second ring section are movably attached together by a hinge.

19. A system for suppressing a vortex-induced vibration (VIV) of a tubular, the system comprising:

a VIV suppression device having a first side wall and a second side wall, the first side wall and the second side wall having interfacing surfaces that taper toward one another to form a substantially triangular shaped region against an underlying tubular;

at least one support member positioned within the triangular shaped region, and in contact with, the interfacing surfaces of the first side wall and the second side wall;

a copper plate attached to a top end of the VIV suppression device, wherein the copper plate comprises a triangular shape;

a first engaging member comprising a bolt fixedly attached to the at least one support member and extending above the copper plate of the VIV suppression device, wherein the bolt is dimensioned to directly engage with an adjacent VIV suppression device; and a second engaging member positioned at the bottom end of the VIV suppression device, and

wherein the second engaging member is different than the bolt.

\* \* \* \* \*